EVALUATION OF SAPSTAIN CONTROL CHEMICALS ON EASTERN SPRUCE-FIR AND WHITE PINE

Norman Whitney (PhD)
(Principle Investigator)

John Johnson
Shaun Price
Ronald Belczewski
(Research Assistants)

Wood Science and Technology Centre
University of New Brunswick
Fredericton, N.B.

March 1990

GOVERNMENT OF
NEW BRUNSWICK

GOUVERNEMENT DU
NOUVEAU-BRUNSWICK

This publication is jointly funded under
the Canada/New Brunswick Industrial
Development Subsidiary Agreement.

GOVERNMENT OF
CANADA

Atlantic Canada
Opportunities
Agency

GOUVERNEMENT DU
CANADA

L'Agence des
perspectives de
l'Atlantique Canada

SUMMARY

Among ten chemicals tested for control of sapstain on spruce/fir mix and white pine, Busan 30WB, Woodgard EC, and BL1118 gave the best ($P<0.05$) protection. Following these, NP-1 was significantly better ($P<0.05$) than PQ-8 for both species group of lumber. NP-1-treated lumber of both species group displayed the fewest molds.

TABLE OF CONTENTS

	Page
SUMMARY	iii
LIST OF TABLES	v
LIST OF FIGURES	vi
ACKNOWLEDGEMENTS	iv
1.0 INTRODUCTION	1
2.0 MATERIALS AND METHODS	3
2.1 Site	3
2.2 Lumber	3
2.3 Mixing of Chemicals	4
2.4 Treatment of Lumber	4
2.5 Evaluation	6
2.6 Data Analysis	6
3.0 Results	9

LIST OF TABLES

		Page
Table 1.	Active ingredients of antisapstain chemicals used in the field test	5
Table 2.	Number of pieces in each stain category for the spruce/fir mix under various treatments	10
Table 3.	Number of pieces in each stain category for the white pine under various treatments	14
Table 4.	Antisapstain treatments of spruce/fir mix ranked from most to least effective treatment, with different letters differing significantly	17
Table 5.	Antisapstain treatments of white pine ranked from most to least effective treatment, with different letters differing significantly	18
Table 6.	Number of pieces of spruce/fir mix with fungi and stains under the various treatments	20
Table 7.	Number of pieces of white pine with fungi and odd-coloured stains under the various treatments	21

LIST OF FIGURES

		Page
Figure 1.	Examples showing evaluation categories	7
Figure 2.	Examples of typical control with each of the tested products	19

ACKNOWLEDGEMENTS

The Wood Science and Technology Centre would like to recognize contributions to this project from the following:

Maritime Lumber Bureau

Buckman Laboratories of Canada Ltd.

Janssen Pharmaceutica

Maag Agrochemicals Inc.

Diachem Industries Ltd.

Chemcraft Sadolin Atlantic Ltd.

Fraser Inc.

1.0 INTRODUCTION

Sapstain on lumber in Atlantic Canada results in economic loss to lumber producers. Sapstain is caused by fungal growth on the surface of sapwood of freshly-sawn lumber resulting in discoloration of the wood. These fungi include molds, usually visible on the wood surface, as well as 'staining' fungi, commonly known as bluestain or sapstain fungi, are capable of penetrating and growing deep within the wood. This growth makes mechanical removal of stained sapwood virtually impossible whereas surface molds can be brushed or 'surfaced' off. This discoloration may completely cover the sapwood, or it may appear as patches, spots, or streaks. This reduces the aesthetic quality of the wood. Ordinarily, sapstain affects the strength of the wood only slightly and thus is not considered to be wood-destroying. However, because the stain is unsightly, it does affect the dollar value of the lumber considerably.

Traditional control of sapstain has consisted of treatment of freshly-sawn lumber with Pentachlorophenol (PCP) formulations. Recent banning of PCP's in some importing countries has necessitated the adoption of alternative fungicides for sapstain control. Some of these fungicides have already been registered and are available for industrial use, while others are awaiting possible registration. In Canada the major testing of these compounds has been carried out by Forinteck Canada Corporation on species from Western Canada. Because conditions for growth of tree species as well as fungal stains in Eastern Canada are

different than in Western Canada, there is a need to test these fungicides under conditions in Eastern Canada. As a result of this, in June 1989, an experiment was set up at the Wood Science & Technology Centre, Fredericton, N.B., to evaluate the effectiveness of ten fungicides for the control of sapstain on freshly-sawn white pine as well as spruce-fir mixture grown in New Brunswick. This is a report of the first scheduled observations three months after the treatments were administered.

2.0 MATERIALS AND METHODS

2.1 SITE

The test site was located in a fenced area of the Hugh John Flemming Forestry Complex, Fredericton, N.B. Buildings with available water were adjacent to one side of the area while an adjoining side faced the University of New Brunswick Woodlot. The other two sides were adjacent to a sawmill yard. The ground was generally dry with some areas heavily covered by weeds. A relatively flat section of the site was used to avoid moisture accumulation.

In preparing the site, six rows were covered with clear plastic (3 m wide) to suppress weed growth and protect the ground from the test compounds. The plastic was held in place with pieces of lumber lined around the perimeter of each sheet.

2.2 LUMBER

The species of lumber (2x4x6-8') tested were eastern white pine (WP), purchased from Russell & Swim Ltd., Doaktown, N.B., and eastern spruce/balsam fir mixture (spruce/fir mix) on loan from Fraser Inc., Edmundston, N.B. Initial inspection revealed stained sapwood on some pieces. The spruce/fir mix was separated into clear (no stain) and stained lumber. The WP showed considerable surface staining, therefore, it was planed (1/8" removed from each surface). As some staining fungi had penetrated beyond the 1/8" depth, the resurfaced WP was also separated

into clear and stained pieces.

Bundles were prepared consisting of 42 pieces each, seven pieces high by six wide. The central 20 pieces were clear surrounded by 22 pieces showing signs of staining (rough lumber in the case of WP). These "edge" pieces served as a buffer from the external environment (wind, sunlight) and as a potential source of 'stain' inoculum.

2.3 MIXING OF CHEMICALS

Ten fungicides were tested (Table 1). All compounds were mixed with water in 10-litre batches on the test site. Concentrations were determined using manufacturer's suggested values or concentrations used in other tests. In the case of a suggested range the mid-point between high and low values was used.

The compounds were placed in 10-L vessels and water was added slowly to reduce the production of foam. The mixture was stirred and placed in steel dipping troughs (15 cm x 15 cm x 2.5 m) lined with expoxy.

2.4 TREATMENT OF LUMBER

Each compound was tested on five randomly-placed bundles, giving a total of 100 test pieces. Each piece of lumber was totally immersed and, upon removal, shaken three times to remove excess liquid. It was then stacked according to the original bundle design. Each treated bundle was tightly fastened with two metal straps.

Table 1. Active ingredients of antisapstain chemicals used in the field test.

Chemical	Registration*	Active ingredients	Percent active ingredient in test solution
BL 1118	No	2-thiocyanomethyltiobenzothiozole (TCMTB)	0.9
Busan 1030	Yes	TCMTB	0.9
Busan 30WB	Yes	TCMTB	0.9
Ecobrite	Yes	Sodium carbonate and sodium metaborate	50.0
NP-1	No	3-iodo-2-propynylbutylcarbonate (IPBC)	0.14
		Didecyldimethylamoniachloride	2.50
Nytek G.D.	Yes	Copper-8-hydroxyquinolinolate	1.25
PQ-8	Yes	Copper-8-hydroxyquinolinolate	0.02
Rodewod 300TR	No	Azaconazole	0.45
Rodewod 500NF	No	Azaconazole	0.45
Woodgard E.C.	No	1PBC	0.14

*Refers to current registration in Canada for use in control of sapstain.

Formulators

BL 1118)
Busan 1030) Buckman Laboratories of Canada Ltd.
Busan 30WB)

Ecobrite Canadian Forest Products Ltd.

NP-1 Kop-Coat Inc.

Nytek G.D. Maag Agrochemicals Inc.

PQ-8 Chapman Chemical Company

Rodewod Janssen Pharmaceutica

Woodgard EC Chemcraft Sadolin Inc.

All ten compounds were tested on the spruce/fir mix. Eight compounds were tested on the white pine (Nytek G.D. & Ecobrite were not tested). Two controls, air (no dipping) and water, were included with each test species.

For safety, anyone involved in mixing the compounds and dipping the pieces wore protective outerwear. This consisted of hats, disposable cover-alls, rubber boots, gloves, goggles and respirators with canisters rated for the compounds being used. All mixing was done on several layers of plastic away from general activity.

2.5 EVALUATION

To insure continuity throughout the experiment all evaluations were done by one person. Each piece was evaluated visually for the amount of sapstain coverage and the value was recorded. There were six categories numbered 0-5: (0) no stain; (1) trace of stain (up to 5% coverage); (2) 25 (more than 5% but not more than 25% coverage); (3) 50 (more than 25% but not more than 50% coverage); (4) 75 (more than 50% but not more than 75% coverage); (5) 100 (more than 75% up to 100% coverage). The percentage of pieces in each category for each treatment was calculated. The presence of molds and decay-causing fungi was recorded. Figure 1 shows examples of each of the six categories.

2.6 DATA ANALYSIS

To evaluate the variances within and between the treatments and controls, each category was weighted to a certain numerical

FIGURE 1. EXAMPLES SHOWING EVALUATION CATEGORIES.

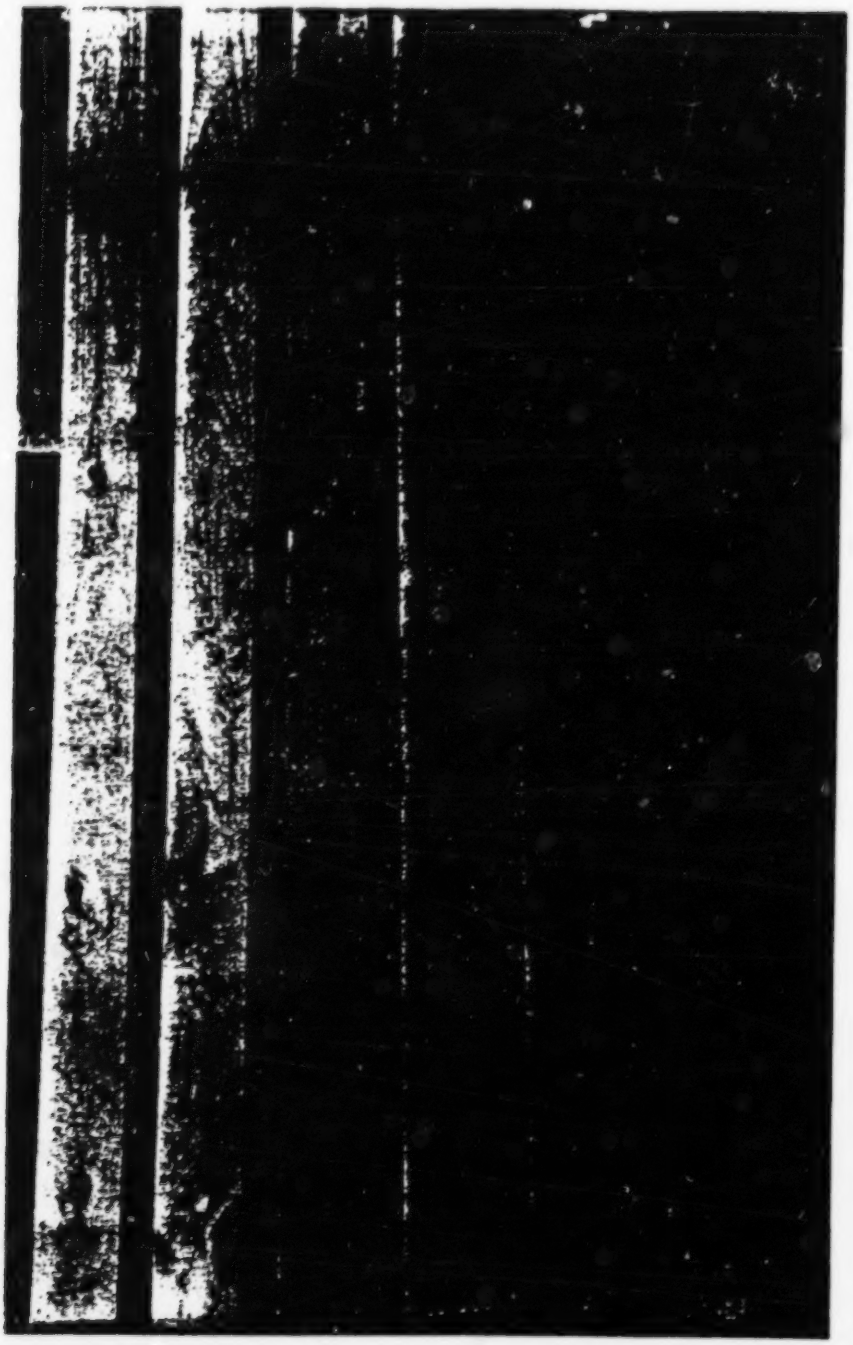

Photo by
S. Price

From left to right: (0) no stain; (1) trace of stain (up to 5% coverage); (2) 25 (more than 5% but not more than 25% coverage); (3) 50 (more than 25% but not more than 50% coverage); (4) 75 (more than 50% but not more than 75% coverage); (5) 100 (more than 75% up to 100% coverage).

value. The value assigned to each category was as follows:

category 0 = 0

category 1 = 1

category 2 = 2.4

category 3 = 3.9

category 4 = 5.0

category 5 = 5.9

These numbers were calculated by using the midpoints of the ranges represented by each category ("0" in the case of category 0) and manipulated as follows:

category	0	1	2	3	4	5
midpoint	0	2.5	15	37.5	62.5	87.5
divided by 2.5[1]	0	1	6	15	25	35
square root value[2]	0	1	2.4	3.9	5.0	5.9

Each piece was assigned the numerical value of the category in which it occurred. These values were then used in a Tukey HSD multicomparison test of significance[3].

---

[1]Dividing by 2.5 expresses each category as a ratio to category 1 (i.e. category 2 has a 6:1 ratio of stain compared to category 1).

[2]Taking the square root of the percentage of piece covered compensates the exponential growth characteristics of the sap stain fungi, assuming that their carrying capacity isn't met until sometime after 75% of the piece is stained.

[3]Runyan, Richard P. 1985. Fundamentals of Statistics in the Biological, Medical, and Health Sciences. Duxbury Press, Boston.

3.0 RESULTS

Air- and water-control bundles had stain ratings as high as category 5, while all chemicals were no higher than category 3 for both the spruce/fir mix and the white pine (Tables 2 and 3).

The results for sapstain prevention and/or control, are presented in Tables 4 and 5.

For spruce/fir mix (Table 4) the best protection was by Busan 30WB, Busan 1030, Woodgard, BL1118, and NP-1. These did not differ significantly ($P<0.05$). With the exception of NP-1, these were all significantly better than the remaining chemicals. In the remaining chemical treatments the only significant differences were between PQ-8 and Ecobrite, and between PQ-8 and Rodewod 300TR.

For white pine (Table 5) the best protection was by BL1118, Busan 30WB, and Woodgard. These did not differ significantly. All three of these were significantly better than the rest of the chemicals except for Busan 1030. Among the remaining chemicals Busan 1030 was the best. Rodewod 300TR, Rodewod 500NF, and NP-1 were not significantly different from each other, while PQ-8 was the least effective. Figure 2 shows examples of typical control with each of the tested products.

For both types of lumber all test chemicals were significantly better than the controls.

Tables 6 and 7 show information about molds and stains observed on the lumber under the various treatments. For both

types of lumber, air and water controls displayed the greatest frequency of possible decay-causing fungi. NP-1-treated lumber of both types had the fewest molds. For white pine all treatments had some effect on Trichoderma. For spruce/fir mix Busan 30WB, Nytek G.D. and Rodewod 300TR were similar to the controls, while PQ-8 was much higher (Table 6).

In both species groups, black stain was most frequent followed by a pink stain in the spruce fir mix and an orange stain on the white pine.

Table 2. Number of pieces in each stain category for the spruce/fir mix under various treatments.

Treatment	Stain Category	Rep. 1	2	3	4	5	6	7	Total[1]
BL 1118	0	2	10	0	1	1	8	--[2]	22
	1	16	10	13	10	12	10	--	71
	2	2	0	7	6	7	2	--	24
	3	0	0	0	1	0	0	--	1
	4	0	0	0	0	0	0	--	0
	5	0	0	0	0	0	0	--	0
Busan 1030	0	1	1	4	0	3	--	--	9
	1	19	19	16	18	10	--	--	82
	2	0	0	0	2	7	--	--	9
	3	0	0	0	0	0	--	--	0
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
Busan 30WB	0	8	2	16	7	1	--	--	34
	1	11	17	2	13	8	--	--	51
	2	1	1	2	0	11	--	--	15
	3	0	0	0	0	0	--	--	0
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0

Table 2. (Continued).

Treatment	Stain Category	Rep. 1	2	3	4	5	6	7	Total[1]
Ecobrite	0	2	2	1	0	0	--	--	6
	1	16	7	12	12	10	--	--	44
	2	2	11	7	7	9	--	--	48
	3	0	0	0	1	1	--	--	2
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
NP-1	0	9	2	0	2	1	--	--	14
	1	9	13	16	16	11	--	--	65
	2	2	5	3	2	8	--	--	20
	3	0	0	1	0	0	--	--	1
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
Nytek G.D.	0	4	0	2	0	0	--	--	6
	1	10	13	11	5	5	--	--	44
	2	6	7	7	15	13	--	--	48
	3	0	0	0	0	2	--	--	2
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0

Table 2. (Continued).

Treatment	Stain Category	Rep. 1	2	3	4	5	6	7	Total[1]
PQ-8	0	1	2	0	0	0	--	--	3
	1	13	14	4	1	5	--	--	37
	2	6	4	15	16	12	--	--	53
	3	0	0	1	3	3	--	--	7
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
Rodewod 300TR	0	1	2	1	1	0	--	--	5
	1	13	18	18	7	7	--	--	53
	2	6	0	11	12	12	--	--	41
	3	0	0	0	0	1	--	--	1
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
Rodewod 500NF	0	0	1	0	0	0	--	--	1
	1	9	13	12	2	4	--	--	40
	2	6	6	8	17	15	--	--	52
	3	1	0	0	1	1	--	--	3
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0

Table 2. (Continued).

Treatment	Stain Category	Rep. 1	2	3	4	5	6	7	Total[1]
Woodgard	0	4	3	2	7	2	--	--	18
	1	15	15	16	13	10	--	--	69
	2	1	2	2	0	8	--	--	13
	3	0	0	0	0	0	--	--	0
	4	0	0	0	0	0	--	--	0
	5	0	0	0	0	0	--	--	0
Air Control	0	1	1	1	0	0	--	--	3
	1	0	4	8	0	0	--	--	12
	2	15	11	11	20	10	--	--	67
	3	3	2	0	0	9	--	--	14
	4	1	2	0	0	1	--	--	4
	5	0	0	0	0	0	--	--	0
Water Control	0	0	0	0	0	1	0	0	1
	1	2	1	1	5	2	0	0	11
	2	12	16	11	12	12	8	16	87
	3	6	2	7	3	4	10	3	35
	4	0	1	1	0	1	2	1	6
	5	0	0	0	0	0	0	0	0

[1]Total number of pieces tested in each treatment = 100 except for BL 1118 = 118, Rodewod 500NF = 86, and Water Control = 140.

[2]Rep. not included in the treatment indicated.

Table 3. Number of pieces in each stain category for the white pine under various treatments.

Treatment	Stain Category	Rep. 1	2	3	4	5	Total[1]
BL 1118	0	5	8	13	10	12	48
	1	15	12	7	10	7	51
	2	0	0	0	0	1	1
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Busan 1030	0	5	1	4	3	4	17
	1	15	19	15	16	16	81
	2	0	0	1	1	0	2
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Busan 30WB	0	3	4	14	6	4	31
	1	17	16	6	13	16	68
	2	0	0	0	1	0	1
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0

Table 3. (Continued).

Treatment	Stain Category	Rep. 1	2	3	4	5	Total[1]
NP-1	0	0	1	5	0	0	6
	1	14	15	12	10	13	64
	2	6	4	3	10	7	30
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
PQ-8	0	1	0	0	0	0	1
	1	1	3	3	5	3	15
	2	17	14	17	11	17	76
	3	1	3	0	4	0	8
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Rodewod 300 TR	0	2	5	3	1	6	17
	1	12	9	12	12	10	55
	2	6	6	5	6	4	27
	3	0	0	0	1	0	1
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0

Table 3. (Continued).

Treatment	Stain Category	Rep. 1	2	3	4	5	Total[1]
Rodewod 500NF	0	0	1	3	0	0	4
	1	15	14	16	14	17	76
	2	5	5	1	6	3	20
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Woodgard	0	4	4	7	6	7	24
	1	16	13	17	10	12	68
	2	0	0	1	3	0	4
	3	0	0	0	0	0	0
	4	0	0	0	0	0	0
	5	0	0	0	0	0	0
Air Control	0	0	0	0	0	0	0
	1	0	0	0	0	0	0
	2	5	13	7	7	6	38
	3	11	7	9	4	12	50
	4	3	0	4	2	2	11
	5	1	0	0	0	0	1
Water Control	0	0	0	0	0	0	0
	1	0	0	0	0	0	0
	2	8	8	14	10	7	47
	3	8	11	5	10	9	43
	4	4	1	1	0	4	10
	5	0	0	0	0	0	0

* Total number of pieces tested in each treatment = 100.

Table 4. Antisapstain treatments of spruce/fir mix ranked from most (A) to least (E) effective treatment, with different letters differing significantly (95% confidence).

Busan 30WB	A
Woodgard	A
Busan 1030	A
BL 1118	A
NP-1	AB
Ecobrite	BC
Rodewod 300TR	C
Nytek	CD
Rodewod 500NF	CD
PQ-8	D
Air	E
Water	E

Table 5. Antisapstain treatments of white pine ranked from most (A) to least (E) effective treatment, with different letters differing significantly (95% confidence).

BL 1118	A
Busan 30WB	AB
Woodgard	AB
Busan 1030	B
Rodewod 300TR	C
Rodewod 500NF	C
NP-1	C
PQ-8	D
Water	E
Air	E

FIGURE 2. EXAMPLES OF TYPICAL CONTROL WITH EACH OF THE TESTED PRODUCTS.

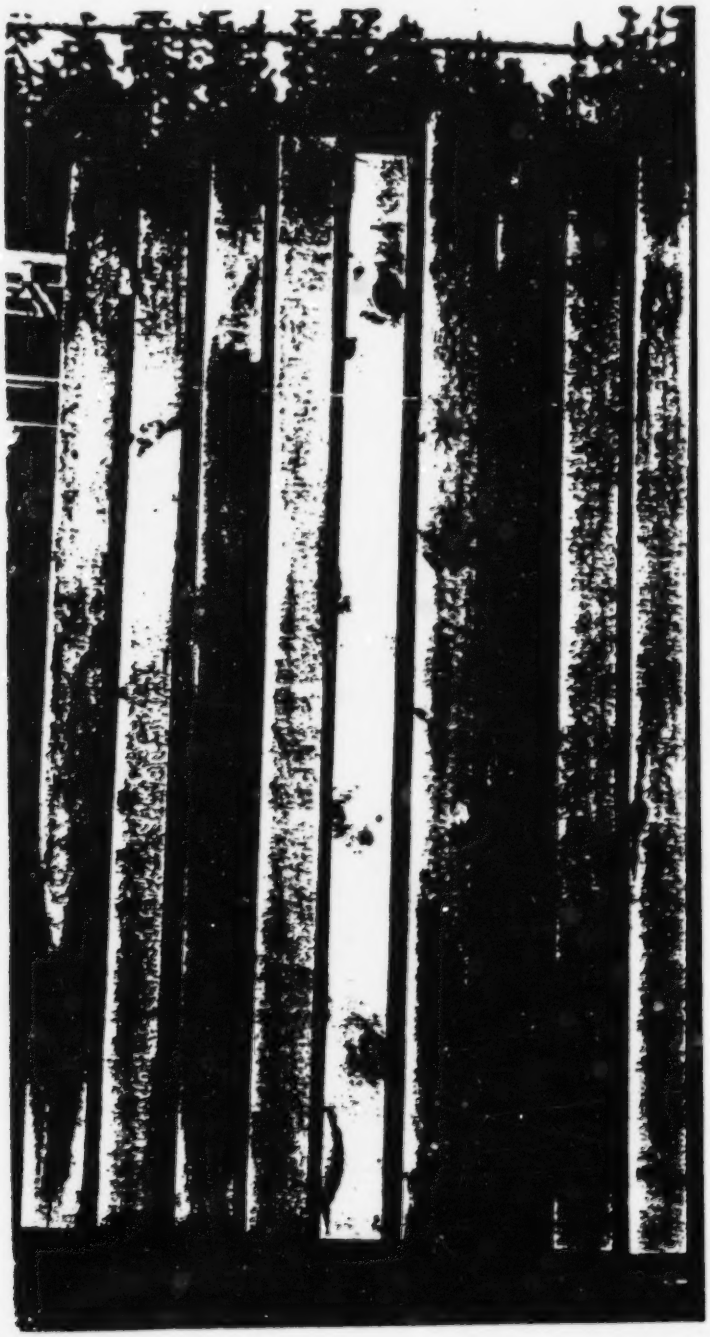

Photo by
S. Price

From left to right: Water, BL 1118, Rodewod 300TR, Rodewod 500NF, Busan 1030, Busan 30WB, PQ-8, NP-1, Woodgard EC.

Table 6. Number of pieces of spruce/fir mix with fungi and stains under the various treatments.

Treatment	Molds		Other	Stain			
	Tricho-derma	Other	Fungi*	Pink	Yellow	Orange	Purple
BL 1118	21	10		2			2
Busan 1030	20	12		2			
Busan 30WB	31	18					
Ecobrite	8	28					
NP-1	8	9					
Nytek	33	28	2				
PQ-8	52	33	1	2			
Rodewod 300TR	30	37		2		1	1
Rodewod 500NF	15	26	1				
Woodgard	4	20	1				
Water	34	36	53	3	1		3
Air	36	39	24	4			

* Not related to stain or decay.

Table 7. Number of pieces of white pine with fungi and odd-coloured stains under the various treatments.

Treatment	Molds		Other	Stain				
	Tricho-derma	Other	Fungi*	Pink	Yellow	Orange	Red	Other
BL 1118	7	9	2			4		
Busan 1030	13	11	1			3		
Busan 30WB	6	5	4		1	4		
NP-1		4	1	2	5	2		
PQ-8	22	27	15	1	1	1		
Rodewod 300TR	16	10						
Rodewod 500NF	22	17	9	1	1	21		
Woodgard	7	8	3			5	3	
Water	39	30	32		7	19	2	7 (grass green)
Air	43	42	36	3	15	22	5	3 (brown) 17 (orange with yellow)

* Not related to stain or decay.